FEDERAL AID
ANNUAL RESEARCH PERFORMANCE REPORT

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 25526
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PROJECT TITLE: Population dynamics of moose in Alaska: Effects of nutrition, predation, and harvest

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FEDERAL AID GRANT PROGRAM: Wildlife Restoration

GRANT AND SEGMENT NR: W-33-2

PROJECT NR: 1.57

WORK LOCATION: Game Management Unit 20A

STATE: Alaska

PERIOD: 1 July 2003–30 June 2004

I. PROGRESS ON PROJECT OBJECTIVES SINCE PROJECT INCEPTION

OBJECTIVE 1: Review literature on moose biology, indices of nutritional status, ungulate population models, predator–prey relationships, and harvest data.

We continue to review available scientific literature using Internet searches.

OBJECTIVE 2: Estimate and evaluate the usefulness of several reproductive and condition indices for moose in Unit 20A and investigate the influence of weather on these parameters.

During the previous 5-year study we documented that reproduction and body weights were compromised at the current high, stable moose density. A 10% decline in the expected proportion of calves in the immediate postcalving population was substantial enough to contribute to the stability of the population in a measurable fashion. To derive an expected proportion of calves in a postcalving moose population, we used a value measured in a low density moose population in Unit 20E where food was not deemed a significant limiting factor to moose. We concluded that density-dependent nutritional limitation is apparent today in Unit 20A and an expected result of maintaining moose at high density. Predation was equally important in limiting population growth during this study, and is a more apparent limiting factor.

An untested hypothesis is whether large-scale adverse weather is needed to initiate a decline in numbers and how productivity responds during such adverse weather. Previously, we have questioned the validity of a long-term carrying capacity because adverse weather has initiated strong declines in moose numbers in the past, and the adverse effects of weather and predation appeared to work in a synergistic fashion to rapidly reduce population size. If adverse weather further reduces productivity, this would be clear evidence that weather-induced resource limitation is a strong secondary influence on moose populations at least at the current high density. If adverse weather acts in a density-independent fashion to reduce high and low density moose populations as per conventional wisdom, then high density populations should be left with more moose following adverse weather compared with low density populations. This would be a potential benefit of managing moose at high densities, in addition to the consumptive and nonconsumptive benefits.

Weather was favorable during this reporting period but parturition rates were similar to the low levels observed during the previous 9 years. We observed the lowest rates in 2001 following the relatively short prior summer of 2000. The short summer of 2000 had relatively few snow-free days and was relatively cool with a relatively low number of growing degree days. We hypothesize that the elevated parturition rates observed during 2004 was an alternate year response to the short summer of 2000, not to any apparent improvement in weather during summer 2003. For example, we observed the lowest parturition rate for cows 4 years and older in 2001 (63% of 68 cows ≥4 years old gave birth). By not giving birth in 2001, cows apparently recovered well and in 2002 produced the highest parturition rates observed during 1996–2002 (87.5% of 80 cows ≥4 years old gave birth). Our hypothesis is that this elevated productivity stressed the cows because in 2003 we again observed the identical low parturition rate (63% of 93 cows ≥4 years old gave birth) observed in 2001. To test this hypothesis we predicted a high rate in 2004 and a reduced rate again in 2005 assuming no adverse weather. As predicted, we observed a high pregnancy rate in 2004; 89% of 104 cows ≥4 years old gave birth. This is the highest pregnancy rate observed to date since studies began in Unit 20A in 1996.

Since 1996 we have observed a parturition rate of only 67% (n = 688) and a twinning rate of only 9% (n = 463) for radiocollared moose ≥3 years old. Strong age-specific indicators of nutritional stress were even more noteworthy: 1) no 24-month-old moose (n = 38) were pregnant, 2) only 29% of 144 36-month-old moose were observed parturient, and 3) no observed moose less than 60 months old produced viable twins. We documented a minimum 20% decline in production with a 3.2-fold increase in density since 1978. However, the substantial increase in moose numbers has allowed far greater sustainable yields than would have been possible at the lower density.

Transrectal ultrasonography and PSPB analyses produced identical results in 1996; the only year in which both results were available. However, daily observations during the calving seasons indicate lower actual productivity in the population and less variability than indicated using ultrasound or PSPB. We use observed parturition rates as the best indicators of production in the population because they are most meaningful to the population and because of the likelihood of neonatal or intrauterine mortality in this high-density population.

Management staff have flown spring twinning rate transect surveys in central portions of the Tanana Flats for several decades without the use of radiocollared moose. Because these surveys more readily sampled moose from all age classes each year, these surveys more accurately estimated annual twinning rates in the population compared with our sampling which is biased by young age classes during most years. To further investigate the accuracy of twinning rate transect surveys, we tested whether differences in twinning rates could be observed with a helicopter versus a fixed-wing aircraft and found no significant differences.

Weighing short yearling moose appears to be a particularly useful and relatively inexpensive tool for evaluating moose population condition. For example, we noted substantial differences between weights in the adjacent Denali and Unit 20A populations. We also noted significant differences in weights between subpopulations within the study area. Short yearlings weighed in the Tanana Flats have weighed significantly less (about 17 kg less on average) than those in the Alaska Range foothills every year that sampling was robust. Although virtually all calves are born in the Tanana Flats, calves that move to the Alaska Range foothills in summer or autumn must have an improved energy balance relative to those remaining in the Tanana Flats. Because of the reduced moose body weights in the Tanana Flats, we have assigned the Tanana Flats a higher priority for improving moose habitat compared to the Alaska Range foothills.

We expected birth weights to provide a relatively sensitive index to winter and spring maternal and range condition and that elevated birth weights would occur among the Alaska Range foothills subpopulation, in part because short yearlings weighed significantly more in the Alaska Range foothills. However, birth weights may provide only a nonsensitive index to winter and spring conditions. For example, we found no significant differences in newborn singleton or twin birth weights with regard to dam collaring location or capture year. As expected, newborn weights in Unit 20A are relatively low compared with those from the Yukon Flats, where moose density is 85% lower and the observed twinning rate (63%) indicates a high nutritional status during ovulation. Our unique finding of a significant difference in birth weights between singleton male and female moose calves may be an indication of the relatively poor nutritional status of moose in Unit 20A.

Depth of rump fat is an index to the condition of individual moose, and potentially an index to relative condition of a moose population. We initially hoped to contrast annual differences in rump fat depths among young moose, e.g., moose in the 10- and 22-month-old cohorts, to provide a tool to evaluate annual differences in moose condition. However, we detected no rump fat among moose in these cohorts. This lack of rump fat apparently is a sign of malnutrition at the current high densities, given that some 22-month-old moose have fat in Denali National Park.

Because short yearling bodyweights differed between the Tanana Flats and the foothills, we expected to find significant differences in adult rump fat depths from these 2 subpopulations. However, we found no significant differences. We conclude that adult rump fat depths are less sensitive indices of nutrient regime compared to short yearling bodyweights, presumably because rump fat depths were gathered from a sample of adults of all ages and reproductive histories. Perhaps with a greater sample size, rump fat depths could be used to detect significant differences in nutrient regimes in these subpopulations.

We conclude that rump fat depth is a more expensive and, at times, less sensitive index to nutrient regime in moose compared to twinning rates and weights of short yearlings. We did find significant relationships between March rump fat depths and reproductive status of females, but reproductive indices are much less expensive to collect than fat depths.

Mean maximum depth of rump fat was significantly greater among pregnant versus nonpregnant adult cow moose. Mean maximum depth of rump fat was also significantly greater for moose observed parturient versus those never observed with a calf and for dams giving birth to twins versus those with singletons. We also found that the fattest dams produced the heaviest calves and calved earlier than dams with low rump fat.

With the blood obtained from adult female moose in 1996 and 1997, we attempted to identify potential relationships between 22 serum constituents and rump fat depth using multiple regression models. We conclude, at this time, that standard serum constituents are not useful indicators of rump fat reserves in moose. In addition, the acute phase protein haptoglobin was not helpful in distinguishing stressed from nonstressed individuals.

OBJECTIVE 3: Estimate causes and respective rates of mortality among radiocollared moose of various age classes in Unit 20A.

A composite of all mortality of radiocollared moose by age from May 1996 through June 2004 indicates that annual calf survival rate was 54% for both sexes. These data are from 79 newborn calves we collared in May 1996 and 1997 and 254 additional male and female short-yearlings we collared during March 1997–2004. We also maintained a representative sample of random adult females throughout this study. Thus most of the data for older cohorts is female-specific. This is the second reporting period in which we collared significant numbers of male short yearlings. Thus we are just beginning to assess sex-specific differences in mortality rates.

The annual composite yearling survival rate for females from mid-May 1997 through mid-May 2004 was 84%. In comparison, the 2-year-old though 5-year-old annual composite rates ranged from 97% to 100%. These rates averaged 94% for ages 6 through 10 years, and declined further to 83% for ages 11 through 16. No moose were known to live to 18 years. In conclusion, female moose appear to be most vigorous and capable of avoiding predation from 2 through 5 years of age.

Wolf predation was the major cause of death among adult and yearling moose. In 33 cases where we were able to investigate the cause of death of radiocollared moose older than 24 months, wolves killed 20 (61%), grizzly bears killed 7 (21%), and 6 (18%) died from factors other than predation. Of 40 yearlings (12 to 24-months old) that died, wolves killed 29 (72%), bears killed 8 (20%), and 3 (8%) died from other factors.

Hunters took a nominal harvest of cows in the study area during September 1996 through 1998 and 2000 through 2003. Cow harvests were <1% of the cow population during the first 4 hunts and increased to between 1% and 2% during the last 2 hunts. These were the first legal cow harvests since 1974. Regulations were liberalized in 2002 and further in 2003 and 2004 to encourage harvest of moose other than bulls because bull:cow ratios had declined below the objective of 30 bulls:100cows.

Simultaneous to encouraging harvest of cows and calves, new regulations were enacted to protect middle-age bulls from hunters. We noted a sharp decline in the number of bulls harvested in 2002. Only 363 bulls were reported harvested in September 2002 compared with an average annual harvest of 589 bulls the previous 7 years (range 526–660 bulls).

Sustainable harvests of moose per unit area remained at the highest level observed in Interior Alaska in recent years, despite moose having the lowest reported birth rates and reduced bull harvests. This occurs because harvest constitutes small proportions of all Interior Alaska moose populations so harvest density is strongly correlated with moose density. Unit 20A moose density is the highest in Interior Alaska, and therefore has the highest harvest density.

The 1996 and 1997 radiocollared newborn calves experienced the highest annual survival rates (52–56%) observed during 7 Alaska–Yukon comparable studies. High calf survival undoubtedly contributes to the reduced reproductive performance of this population.

Predation was by far the major proximate cause of death in this and all previous moose calf mortality studies. Wolves killed more calves than both bear species in this study, while grizzly bears and black bears killed about equal proportions of calves. In previous moose calf mortality studies, black or grizzly bears were clearly the major predator. In addition to mortality detected using radiocollared calves, mortality prior to birth or neonatal mortality during the first 24 hours after birth apparently occurred in 7 (17%) of 42 pregnancies in 1996 and 3 (13%) of 23 pregnancies in 1997.

OBJECTIVE 4: Summarize existing statewide reproduction and population data for moose. Currently, there is a need for a single consolidated source for past moose survey information as well as other data collected on condition or reproductive parameters of moose populations within the state.

No progress was made on this objective because Mark Keech was reassigned to Unit 19D moose research studies.

II. SUMMARY OF WORK COMPLETED ON JOBS IDENTIFIED IN ANNUAL PLAN THIS PERIOD

JOB 1: <u>Continue literature review on (1) moose biology and ecology at high densities; (2) indices to nutritional status of ungulates; (3) models of ungulate population dynamics; (4) predator–prey ratios in relation to population dynamics of moose, caribou, sheep, wolves, and grizzly bears; (5) predator/prey relationships in multi-prey, multi-predator systems; and (6) population and harvest data on moose, caribou, sheep, wolves, and bears in Unit 20A.</u>

I routinely reviewed literature as necessary to remain current on relevant aspects of moose biology. Also, Kalin Kellie completed an exhaustive review of the literature on moose movements for her Master's degree. I estimated that 6 person-days were spent on this job during this reporting period.

JOB 2: <u>Estimate and evaluate the usefulness of several reproductive and condition indices for moose in Unit 20A and investigate the influence of weather on these parameters</u>.

There were no capture-related mortalities this reporting period; 46 total moose were captured in early March 2004. We recaptured 22 adult females; most were 69-months-old. We replaced the aging ATS collars that were deployed when these moose were 9 months old. We used blood samples to estimate a pregnancy rate of 95% from PSPB values. We had insufficient funds to measure rump fat depths. We saved funds during capture operations by using an R-22 helicopter for transportation.

We also radiocollared and weighed 21 male short-yearlings and radiocollared 3 male yearlings. As in previous years, capture sites were divided between the Tanana Flats and Alaska Range foothills. During the first 5 years of capture, weights were significantly higher in the foothills (sample sizes totaled 40 or more short-yearlings, 1996–2000 cohorts). This trend continued in the 2001 cohort although we reduced sample size to 20 female short yearlings to allow funding for recollaring adults. In the 2002 cohort we split the 20 collars for short-yearlings between males and females. During this reporting period (2003 cohort), we focused exclusively on collaring young males to investigate age-specific natural mortality rates. This will change the emphasis from evaluating production and natural mortality rates of female cohorts to estimating natural mortality rates of male cohorts.

Approximately 30 fixed-wing radiotracking flights were flown between mid-May and mid-June 2003 to observe parturition and twinning rates of 121 radiocollared moose greater than 2 years old. Of 104 cows ≥4-years old, 93 (89%) were observed with newborn calves during alternate day flights. We observed a twinning rate of 9% among the 74, 5-year-old radiocollared cows. Twinning rates from aerial transect surveys totaled 5% (n = 60 cows with calves). The median calving date was 21 May, similar to previous years. Newborn calves were observed from 11 May through 15 June. Data on weather patterns will be compiled when available from the National Oceanic and Atmospheric Administration.

JOB 3: Assess causes and rate of mortality among radiocollared moose of various age classes in Unit 20A.

To assess causes and rates of mortality of moose within the study area, all radiocollared moose (approximately 150 to 170 moose) were tracked at least monthly with fixed-wing aircraft during this reporting period. Flights were most frequent in the summer. In addition, a helicopter (R-22) was deployed to recover collars and investigate causes of death of 8 collared moose.

JOB 4: Write progress reports and publish a final report. Also, incorporate results into appropriate Alaska wildlife planning, discussions, and management activities.

Data collected from this project are being used in Unit 20A moose management reports, advisory committee meetings, Board of Game meetings, discussions with the public regarding harvest opportunities, and discussions with the Department of Natural Resources regarding the need to improve habitat in Unit 20A using burns. Results to date were also presented at the annual meeting of the Northwest Section of The Wildlife Society in Girdwood, Alaska in May 2004.

III. ADDITIONAL FEDERAL AID-FUNDED WORK NOT DESCRIBED ABOVE THAT WAS ACCOMPLISHED ON THIS PROJECT DURING THIS SEGMENT PERIOD

No additional work was accomplished.

IV. PUBLICATIONS

We made several presentations related to this work at the Northwest Section Meeting of The Wildlife Society in May 2004 (see Appendix for abstracts). We also finalized a paper in May 2004 for *Alces* that we presented at the North American moose conference in Jackson Hole, Wyoming in May 2003 (see Appendix for abstract).

V. RECOMMENDATIONS FOR THIS PROJECT

As recommended last year, we changed the emphasis from females to males when collaring short yearlings. This allowed us to investigate age-specific natural mortality rates of males, as we continue to investigate these rates for older females. No data exists on natural mortality rates of male moose older than calves.

VI. APPENDIX LITERATURE CITED

Boertje, Rodney D., Donald D. Young, C. Tom Seaton, and Craig L. Gardner. 2004. Twenty-plus years of population and habitat studies that support predator control to increase moose harvest in rural Interior Alaska. Oral presentation at the Northwest Section meeting of The Wildlife Society at Girdwood, Alaska in May 2004.

Alaska Department of Fish and Game, 1300 College Road, Fairbanks, AK 99701

Empirical data show that moose in rural interior Alaska live at relatively low densities because of high, largely additive predation from black and grizzly bears and wolves (and a lack of alternate large prey). Sustainable harvests of moose are limited to 4-15 moose/1000 km^2 despite habitat that is adequate to support higher moose densities (indicated by twinning rates, bodyweights, diet, and browse characteristics). In contrast, after wolves were strongly controlled (56-79% reduction, 1976-1982) in 13,044 km^2 near Fairbanks, moose: (1) increased 5-fold and continue to increase, (2) now live at >5-fold higher density and sustain >5-fold higher harvest density than respective rural Interior averages, (3) have supported >7% of the statewide reported moose harvest since 1995 in <1% of the state, and (4) support higher wolf densities than rural areas but with several times more moose per wolf. Habitat declined and is relatively poor in this 13,044 km^2 (lowest twinning rates, lowest bodyweights, highest browse removal rates and prevalence of brooming, and reduced diet quality), yet calf survival is the highest among 6 calf mortality studies in the Interior because predation is relatively low. In most rural systems, grizzly and/or black bears limited moose by killing large proportions of moose calves; calf survival increased significantly following translocation or diversionary feeding of bears. Wolves were significant secondary predators in most rural systems; case histories indicate that only prolonged wolf control elevated moose harvest. No data support the theory that, following significant predator control, sensitive nutritional feedback keeps moose density low. Rather, near Fairbanks, nutritional feedback began 10 years after the initiation of strong predator control (1976-1982) but has not yet halted population growth. Results of this wolf control offer 2 current challenges: (1) garnering support from fire-fighting agencies to rejuvenate habitat, and (2) garnering support for and administering substantial harvests of moose cows and calves.

Donald D. Young, C. Tom Seaton, and Rodney D. Boertje. 2004. Harvest strategies for a high-density moose population. Oral presentation at the Northwest Section meeting of The Wildlife Society at Girdwood, Alaska in May 2004.

Alaska Department of Fish and Game, 1300 College Road, Fairbanks, AK 99701.

To meet demand for high levels of human consumptive use (Intensive Management [IM]) of moose (*Alces alces*) in Unit 20A, the Alaska Department of Fish and Game has recommended moving from harvest strategies directed towards antlered bulls, where yields tend to be lower, to a selective harvest strategy that includes all sex and age classes, where yields tend to be higher. Although harvest strategies historically focused on antlered bulls, antlerless hunts were introduced as early as 1963. Initially, antlerless hunts were of limited magnitude (≤1% prehunt population), but were gradually expanded until by the mid-1970's harvests had became significant (4%-9% prehunt population). Due to the combined effects of severe winters, increased predation, and over-harvest of cows, moose numbers plummeted from an estimated 23,000 (1968) to 2800 (1975). That and the ensuing lack of public support culminated in the suspension of antlerless hunts from 1975-1995, during which time only bulls were legal. Consequently, considerable hunting opportunity was lost, particularly during the 1980s and early 1990s when the moose population grew rapidly. With tenuous public support, antlerless hunts were reinstituted in 1996, primarily to limit population growth, but harvests were low ($\bar{x}$ =68, 1996-2001; ≤1% prehunt population) and likely had minimal effect. High harvest rates of bulls 1995-1999 ($\bar{x}$ =604), which resulted in low sex ratios (23 bulls:100 cows, 1999-2000), subsequently lead to shorter (5 days) seasons in 2000-2001 and lower bull harvests ($\bar{x}$ =544), but harvests still exceeded the estimated sustainable harvest of 400 bulls annually. In 2002-2003, unit-wide antler restrictions, expanded antlerless hunts, and hunts targeting calves were adopted to better distribute the harvest across sex and age classes. This resulted in reduced harvests of antlered bulls (approximately 350), increased harvests of cows ($\bar{x}$ =127), but only minimal harvests of calves ($\bar{x}$ =28.5). To increase yield, our long term strategy is to harvest across sex and age classes at approximately 60 bulls:20 cows:20 calves.

Seaton, C. Tom, Rodney D. Boertje, Thomas F. Paragi, Craig L. Fleener, Steve D. DuBois, and Brad Griffith. 2004. Relationships between removal of browse biomass and moose productivity and density. Oral presentation at the Northwest Section meeting of The Wildlife Society at Girdwood, Alaska in May 2004.

Alaska Department of Fish and Game, 1300 College Road, Fairbanks, AK 99701-1599 (CTS, RDB, TFP);
Council of Athabascan Tribal Governments, 283 East Second Avenue, Fort Yukon, AK 99740 (CLF);
Alaska Department of Fish and Game, P.O. Box 605, Delta Junction, AK 99737-0605 (SDD);
USGS Alaska Cooperative Fish and Wildlife Research Unit, 209 Irving I Building, University of Alaska Fairbanks 99775 (BG)

We studied removal of browse biomass by moose in 4 areas of Interior Alaska, 2000–2003. Our purpose was to document landscape-scale patterns of browse removal over a gradient of moose productivity and density. We estimated the proportion of current annual growth that was removed based on bite diameters and diameter-mass regressions specific to each browse species. In late winter we sampled willow (*Salix* spp.), quaking aspen (*Populus tremuloides*), balsam poplar *(Populus balsamifera*), and paper birch (*Betula papyrifera*) with current annual growth between 0.5 m and 3.0 m above the ground. We estimated browse removal by moose to be 9–42% of current annual growth at the landscape-scale. Browse removal by moose was inversely correlated ($r^2 = 0.94$) with moose twinning rate (range 6–63%) and correlated ($r^2 = 0.89$) with moose density (range 0.15–1.1 moose per km^2). We documented browse removal estimates to (1) evaluate the need for habitat rejuvenation in an area of high density, after predator control; (2) evaluate habitat suitability where predator control was proposed to increase moose density; and (3) provide relative baseline information linking the fields of moose habitat biology and population biology.

DONALD D. YOUNG JR. AND R D. BOERTJE.2004. Initial use of moose calf hunts to increase yield, Alaska**.** Alces (in press)

Alaska Department of Fish and Game, 1300 College Road, Fairbanks, AK 99701-1599, USA

ABSTRACT: In 2002 the Board of Game authorized Alaska's first permit hunts specifically for calf moose (*Alces alces)*. We promoted these calf hunts to help stabilize a high-density, food-stressed moose population and to compensate for declining harvests of bulls. Low harvest rates of cows (≤1% of the prehunt cow population, 1996–2001) were tightly controlled by the public. High harvest rates of bulls (21%–26% of the prehunt bull population, 1995–1999) resulted in bull:cow ratios declining below the management objective of 30:100. To conserve bulls, the previous bag limit of any bull was changed to bulls with specific antler configurations. Simultaneously, 300 calf drawing permits were made available in 7 different hunt areas with the allocation of permits based on estimated moose densities within individual hunt areas. We issued 274 permits, but 61% of the permittees did not participate, in part to protest the hunt. Of 108 hunters, 33 reported taking a calf. The harvest accounted for about 1.3% (33/2500) of the estimated prehunt calf population and 7% (33/471) of the total reported harvest. The calf harvest contributed only marginally to meeting the Game Management Unit 20A harvest mandate of 500–720 moose. We observed decreasing acceptance of calf hunts and increasing acceptance of cow hunts during 2002 and 2003. In 2004 we expect to substantially increase the harvest of cows and calves using registration and late season hunts and continuing education programs. We deem gaining public acceptance of cow and calf hunts in increasing, food-stressed Alaska moose populations to be a long-term, challenging, yet worthwhile endeavor.

VII. PROJECT COSTS FOR THIS SEGMENT PERIOD

FEDERAL AID SHARE $70,896 STATE SHARE $23,632 = TOTAL $94,528

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